

## ROUND 12

### TOSS-UP

1) PHYSICS *Multiple Choice* Often some of the strongest spectral lines in cold interstellar gas are produced by:

- W) neutral lithium
- X) ionized iron
- Y) carbon and iron
- Z) calcium and sodium

ANSWER: Z) CALCIUM AND SODIUM

### BONUS

1) PHYSICS *Short Answer* The cosmic background radiation discovered by Penzias and Wilson closely matches the radiation from a black body with what temperature Kelvin, to the nearest whole number?

ANSWER: 3

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### TOSS-UP

2) CHEMISTRY *Multiple Choice* Which of the following salt solutions, all at 1.0 molar concentration, will have a pH value less than 7:

- W)  $\text{NH}_4\text{Cl}$
- X)  $\text{NaC}_2\text{H}_3\text{O}_2$
- Y)  $\text{KCl}$
- Z)  $\text{LiBr}$

ANSWER: W)  $\text{NH}_4\text{Cl}$

### BONUS

2) CHEMISTRY *Short Answer* Name all of the following 4 compounds that exhibit hydrogen bonding:  $\text{CH}_4$ ;  $\text{H}_2\text{S}$ ;  $\text{NH}_3$ ;  $\text{CH}_3\text{OH}$

ANSWER:  $\text{NH}_3$ ;  $\text{CH}_3\text{OH}$

### TOSS-UP

3) BIOLOGY *Multiple Choice* In early experiments in the mid-1900's, the source and fate of oxygen involved in photosynthesis was mostly determined through experiments that used:

- W) animals in closed containers that would die unless a plant was introduced into the container
- X) a heavy isotope of oxygen as a tracer
- Y) fluorescent labeling of various enzymes and organic products
- Z) simple accounting of the atomic mass of all the reactants and products

ANSWER: X) A HEAVY ISOTOPE OF OXYGEN AS A TRACER

### BONUS

3) BIOLOGY *Short Answer* By number or name, identify all of the following 4 processes that contribute directly to genetic variation in humans: 1) random fertilization of ova with sperm; 2) crossing over; 3) independent assortment; 4) mitosis

ANSWER: 1, 2 AND 3 (ACCEPT: ALL BUT #4)

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### TOSS-UP

4) MATH *Short Answer* If you roll 2 fair dice simultaneously, what is the probability, given as a fraction, that you will roll the number 6 on AT LEAST one die?

ANSWER: 11/36

### BONUS

4) MATH *Short Answer* Find the sum of all interior angles, in degrees, in a regular polygon having 14 sides:

ANSWER: 2,160

(Solution:  $(14 - 2)(180) = 2,160^\circ$ )

### TOSS-UP

5) EARTH SCIENCE *Multiple Choice* Which of the following is the BEST example of a non-point source pollution:

- W) leaching from a landfill
- X) a leaking septic tank
- Y) fertilizer runoff from agricultural fields
- Z) chemical spills at a mining site

ANSWER: Y) FERTILIZER RUNOFF FROM AGRICULTURAL FIELDS

### BONUS

5) EARTH SCIENCE *Short Answer* Arrange the following 4 layers of the Earth's atmosphere in order of INCREASING air pressure: stratosphere; exosphere; thermosphere; troposphere

ANSWER: EXOSPHERE; THERMOSPHERE; STRATOSPHERE; TROPOSPHERE

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### TOSS-UP

6) GENERAL SCIENCE *Multiple Choice* Some vitamin tablets contain high concentrations of zinc and must be formulated to include high levels of which of the following minerals in order to prevent an induced anemia:

- W) copper
- X) calcium
- Y) magnesium
- Z) boron

ANSWER: W) COPPER

### BONUS

6) GENERAL SCIENCE *Short Answer* What is the most common name for the technique that places a molecule in a strong magnetic field, irradiates the molecule with radio waves, and finally detects changes in the spin of atoms in the molecule?

ANSWER: NUCLEAR MAGNETIC RESONANCE (ACCEPT: NMR or MAGNETIC RESONANCE SPECTROSCOPY)

### TOSS-UP

7) ASTRONOMY *Multiple Choice* Landform deposits called linear dunes that were recently found on the moon Titan are MOST directly produced by:

- W) tectonic activity
- X) wind
- Y) erosion by the retreat and advance of large seas of liquid methane
- Z) streaks in the surface following low-angle meteorite impacts

ANSWER: X) WIND

### BONUS

7) ASTRONOMY *Short Answer* What is the magnifying power of the telescope with a focal length of 5 meters and an eyepiece of 20 millimeters?

ANSWER: 250 (ACCEPT: 250X or 250 TIMES)

(Solution:  $5000\text{mm}/20\text{mm} = 250$ )

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### TOSS-UP

8) PHYSICS *Multiple Choice* The process in which an atom reradiates a photon after interacting with an incident photon of the same energy is called:

- W) Rayleigh scattering
- X) the Cherenkov effect
- Y) Bragg's Law
- Z) Thomson scattering

ANSWER: Z) THOMSON SCATTERING

### BONUS

8) PHYSICS *Multiple Choice* A protanomalous person has decreased sensitivity of the red cones in his or her eyes. Which of the following color pairs will this person have difficulty distinguishing between:

- W) red and green
- X) blue and purple
- Y) yellow and turquoise
- Z) dark navy blue and black

ANSWER: X) BLUE AND PURPLE

### TOSS-UP

9) CHEMISTRY *Multiple Choice* Which of the following is typically TRUE of organic compounds:

- W) acetylene contains delocalized pi bonds
- X) the simplest carboxylic acid is ethanoic acid
- Y) ketones have no hydrogen atoms directly attached to the carbonyl group
- Z) alcohols contain nonpolar hydroxyl groups

ANSWER: Y) KETONES HAVE NO HYDROGEN ATOMS DIRECTLY ATTACHED TO THE CARBONYL GROUP

### BONUS

9) CHEMISTRY *Short Answer* Rounded to the nearest whole number, what is the percent of magnesium in magnesium carbonate, given the atomic mass of magnesium is 24 grams per mole?

ANSWER: 29

(Solution:  $\text{MgCO}_3 = 24 + 12 + (3 \times 16) = 84$ ;  $24/84 = 28.57\%$ )

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### TOSS-UP

10) BIOLOGY *Multiple Choice* In the famous experiment by Hershey and Chase that showed DNA was the genetic material, what did they use to transmit the DNA into *E. coli*:

- W) other *E. coli*
- X) electric shocks
- Y) a blender
- Z) bacteriophage

ANSWER: Z) BACTERIOPHAGE

### BONUS

10) BIOLOGY *Short Answer* In the *Amanita* mushroom, what is the name of the cell in which karyogamy and meiosis occur and what is the product of meiosis, respectively?

ANSWER: CELL = BASIDIUM; PRODUCT = BASIDIOSPORE

**TOSS-UP**

11) MATH *Multiple Choice* Which of the following are coterminal angles in standard position (read slowly):

- W)  $550^\circ$  and  $185^\circ$
- X)  $80^\circ$  and  $-190^\circ$
- Y)  $1160^\circ$  and  $800^\circ$
- Z)  $181^\circ$  and  $-118^\circ$

ANSWER: Y)  $1160^\circ$  AND  $800^\circ$

(Solution:  $80 + 3(360^\circ) = 1160^\circ$ ;  $80 + 2(360^\circ) = 800^\circ$ )

**BONUS**

11) MATH *Short Answer* Solve the following equation for  $x$ , expressing your answer in simplest radical form over the real numbers:  $x^4 - 9x^2 + 8 = 0$

ANSWER:  $\pm 2\sqrt{2}$  AND  $\pm 1$  (ACCEPT ALL:  $+2\sqrt{2}$ ,  $-2\sqrt{2}$ ,  $+1$ ,  $-1$ )

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**TOSS-UP**

12) EARTH SCIENCE *Multiple Choice* Which of the following is the BEST example of an ocean current found in the intertidal littoral zone that flows seaward:

- W) rip current
- X) tidal bore
- Y) the Antarctic Circumpolar Current
- Z) equatorial tidal current

ANSWER: W) RIP CURRENT

**BONUS**

12) EARTH SCIENCE *Multiple Choice* Which of the following is NOT true of isotherms:

- W) they are more widely spaced over the equatorial regions
- X) they are more closely spaced over North America in the summer than in the winter
- Y) they tend to be linear in form in the Southern Hemisphere south of  $40^\circ$  latitude
- Z) they are lines that connect places with the same average temperature

ANSWER: X) THEY ARE MORE CLOSELY SPACED OVER NORTH AMERICA IN THE SUMMER THAN IN THE WINTER

### TOSS-UP

13) GENERAL SCIENCE *Multiple Choice* Which of the following instruments is BEST used to image small, transparent and fluorescent specimens and obtain optical sections without the need for mechanical sectioning:

- W) X-ray microanalyzer
- X) scanning electron microscope
- Y) transmission electron microscope
- Z) confocal laser scanning microscope

ANSWER: Z) CONFOCAL LASER SCANNING MICROSCOPE

### BONUS

13) GENERAL SCIENCE *Short Answer* A relatively new scourge to the citrus growers in Florida, what is the common name of the citrus disease caused by a species of bacteria called *C. liberibacter* and spread by an introduced non-native insect?

ANSWER: GREENING (ACCEPT: CITRUS GREENING)

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### TOSS-UP

14) ASTRONOMY *Short Answer* A sidereal drive is a motor on a telescope that turns it in a certain direction to keep the telescope aimed at a certain celestial object. Giving your answer as north, south, east or west, in what direction does it turn?

ANSWER: WEST

### BONUS

14) ASTRONOMY *Multiple Choice* The Wilkinson Microwave Anisotropy Probe was specifically designed to:

- W) map all matter in the universe down to a resolution of 1 arc second
- X) map the cosmic background radiation to much greater accuracy and precision than previous instruments
- Y) map the size and locations of the Local Group
- Z) map the exact location of the active galactic center of the Milky Way

ANSWER: X) MAP THE COSMIC BACKGROUND RADIATION TO MUCH GREATER ACCURACY AND PRECISION THAN PREVIOUS INSTRUMENTS

### TOSS-UP

15) PHYSICS *Multiple Choice* In a compound gearing arrangement where a 40-tooth gear drives an 80-tooth gear which is directly connected to a 50-tooth gear that drives a 100-tooth gear, the total reduction is a factor of:

- W) 2
- X) 2.5
- Y) 4
- Z) 5

ANSWER: Y) 4

### BONUS

15) PHYSICS *Multiple Choice* Elastic deformation is BEST described as:

- W) the linear portion of a stress/strain curve
- X) the ultimate strength of a material
- Y) 0.02% elongation
- Z) permanent deformation

ANSWER: W) THE LINEAR PORTION OF A STRESS/STRAIN CURVE

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### TOSS-UP

16) CHEMISTRY *Multiple Choice* Which of the following elements has the largest second ionization energy:

- W) fluorine
- X) nitrogen
- Y) boron
- Z) lithium

ANSWER: Z) LITHIUM

(Solution: core electrons must be removed)

### BONUS

16) CHEMISTRY *Short Answer* Arrange the following compounds in order of INCREASING ionic characteristic: HCl; LiBr; CO; KF

ANSWER: CO; HCl; LiBr; KF

**TOSS-UP**

17) BIOLOGY *Multiple Choice* Which of the following are MOST often used to introduce foreign genes into mammalian genomes:

- W) sliceosomes (read as: sly-see-oh-somz)
- X) zinc fingers
- Y) plasmids
- Z) telomeres

ANSWER: Y) PLASMIDS

**BONUS**

17) BIOLOGY *Multiple Choice* Which of the following regulate development in animals, plants and fungi, and were first discovered in *Drosophila*:

- W) homeobox (read as: HOME-ee-oh-box) genes
- X) p53
- Y) shock genes
- Z) oncogenes

ANSWER: W) HOMEBOX GENES

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**TOSS-UP**

18) MATH *Short Answer* What function is the inverse of  $y = 3x + 4$ ?

ANSWER:  $y = \frac{x - 4}{3}$

**BONUS**

18) MATH *Short Answer* Giving your answer as an ordered pair, find the solution of the system of the following 2 equations:  $2x + 3y = 8$ , and  $3x - 2y = -1$

ANSWER: (1, 2) (ACCEPT: 1 AND 2)

### TOSS-UP

19) EARTH SCIENCE *Multiple Choice* Orthoclase feldspar primarily weathers by which of the following processes to form clay minerals:

- W) abrasion
- X) hydrolysis
- Y) exfoliation
- Z) dissolution

ANSWER: X) HYDROLYSIS

### BONUS

19) EARTH SCIENCE *Short Answer* What is the name for the sedimentary rock that carries high concentrations of organic material in the form of kerogen, which can yield oil when heated and distilled?

ANSWER: OIL SHALE (ACCEPT: SHALE)

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### TOSS-UP

20) GENERAL SCIENCE *Short Answer* Name all of the following 4 reagents that would NOT be labeled as a highly flammable substance:  
methanol; diethyl ether; 30% hydrogen peroxide; benzene

ANSWER: 30% HYDROGEN PEROXIDE

### BONUS

20) GENERAL SCIENCE *Short Answer* What engineering term is MOST commonly used to describe why a shaft with a radius at a transition in diameter is stronger than the same shaft with an abrupt transition in diameter?

ANSWER: STRESS CONCENTRATION (ACCEPT: STRESS CONCENTRATION AT THE CHANGE IN DIAMETER) (DO NOT ACCEPT: STRESS)

**TOSS-UP**

21) ASTRONOMY *Short Answer* If the surface temperature of a given star increased from 20,000K to 60,000K, how many times as much energy would the star release?

ANSWER: 81 (ACCEPT:  $3^4$ )

**BONUS**

21) ASTRONOMY *Short Answer* Name all of the following 4 celestial objects that, when viewed from the Earth, CANNOT be in opposition: Moon; Mercury; Mars; Neptune

ANSWER: MERCURY

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**TOSS-UP**

22) PHYSICS *Short Answer* What specific type of semiconductor is produced by adding phosphorus to silicon?

ANSWER: N-TYPE

**BONUS**

22) PHYSICS *Short Answer* How many turns are in the secondary coil of a transformer that has a primary coil with 20,000 turns and is designed to step down 12,000 volts AC to 120 volts AC?

ANSWER: 200

(Solution:  $12,000/120 = 20,000/x$ ;  $x = 200$ )

### TOSS-UP

23) CHEMISTRY *Short Answer* The hybridization of one 's' (read as: one <pause> s) orbital and 3 'p' (read as: three <pause> p) orbitals and one 'd' (read as: one <pause> d) orbital creates how many  $sp^3d$  hybrid orbitals?

ANSWER: 5

### BONUS

23) CHEMISTRY *Short Answer* A solution contains 0.50 moles of methanol in 100 grams of water. What is the mole fraction of methanol, to the second decimal place?

ANSWER: 0.08 (DO NOT ACCEPT 8.0%)

(Solution:  $100\text{g}/18\text{ g mol}^{-1} = 5.56\text{ moles}$ ;  $0.5\text{ mol}/(5.56 + 0.5) = 0.0825$ )

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### TOSS-UP

24) BIOLOGY *Short Answer* Black water fever is a complication of malarial infection. The term black water comes from what oxidized product in the urine of infected individuals?

ANSWER: HEMOGLOBIN (ACCEPT: MET-HEMOGLOBIN)

### BONUS

24) BIOLOGY *Short Answer* Name all of the following 4 human blood cells that are considered lymphocytes: helper T cells; CD8 cells; CD4 cells; plasma cells

ANSWER: HELPER T CELLS; CD8 CELLS; CD4 CELLS; PLASMA CELLS  
(ACCEPT: ALL)

### TOSS-UP

25) CHEMISTRY *Short Answer* Calculate the atom percent composition, rounded to the nearest whole number, for each atom in acetic acid:

ANSWER: C = 25%; H = 50%; O = 25%

### BONUS

25) CHEMISTRY *Short Answer* Calculate the mass percent composition, rounded to the nearest whole number, for each atom in acetic acid:

ANSWER: C = 40%; H = 7%; O = 53%

(Solution: C =  $24/60 \times 100\% = 40\%$ ; H =  $4/60 \times 100\% = 6.7\%$ ; O =  $32/60 \times 100\% = 53.3\%$ )